



Energy and Climate Change Policy in Denmark

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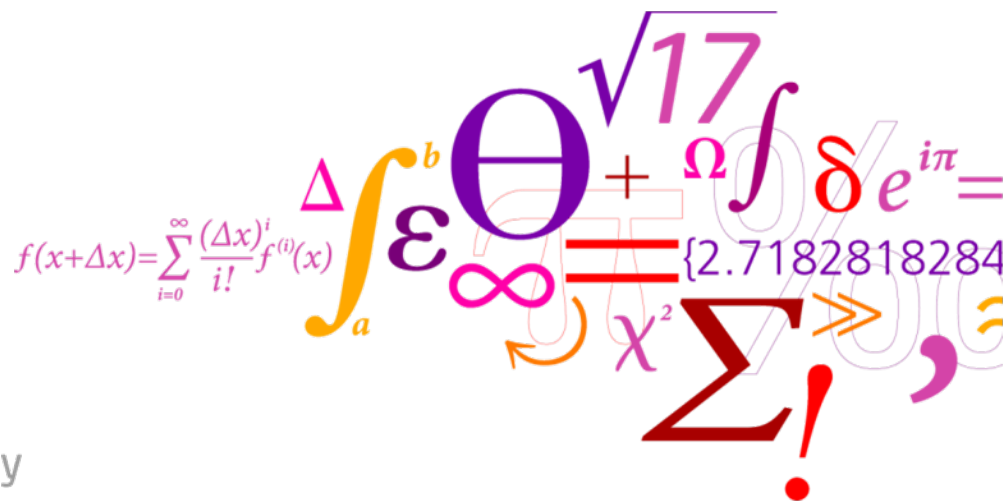
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Energy and Climate Change Policy in Denmark

*JEA Symposium on World Energy and Climate Policy Assessment
Tokyo, 30 November 2010*

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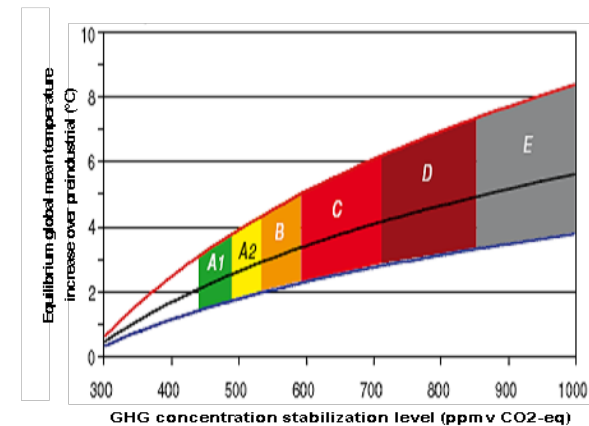
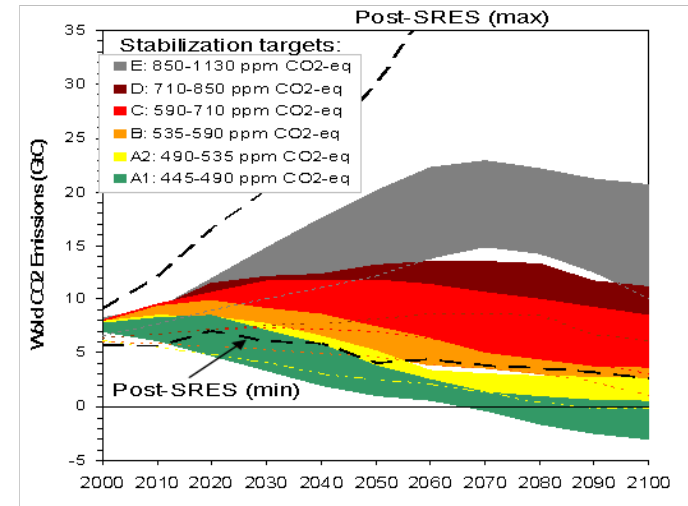
The changing global energy scene

- The global economy has over the last years faced a number of changes and challenges.
- The economic recession may be seen as short term relief with regard to GHG emissions.
- GHG concentrations in the atmosphere have been building up faster than even the most pessimistic scenario predicted by the IPCC.
- Renewable energy sources, which at one time occupied an almost insignificant niche, are gradually expanding their role in global energy supply.

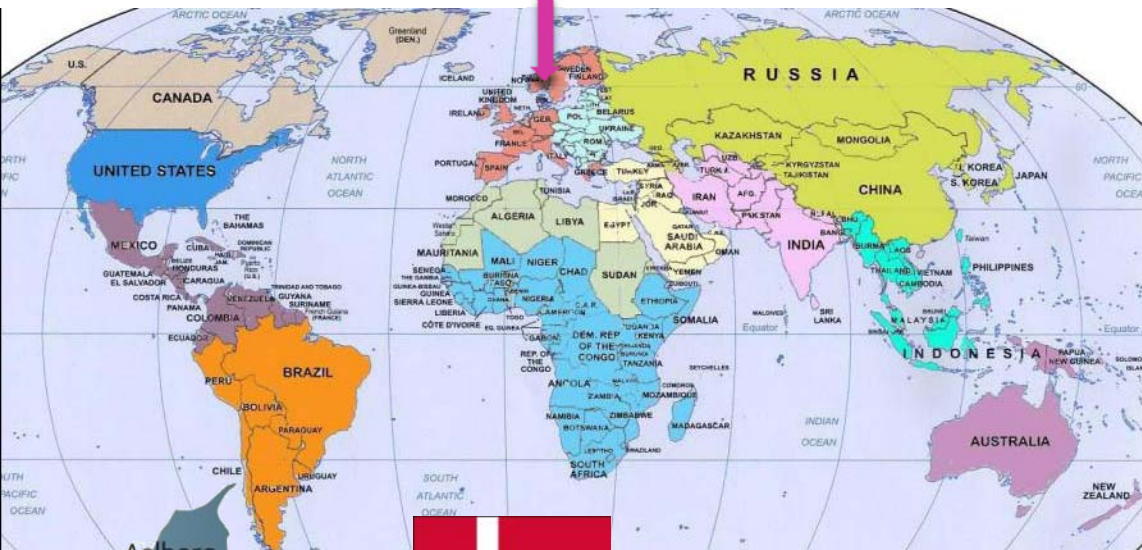


Climate change

- IPCC - 4. assessment report in 2007
- Nobel peace price
- The weak results from COP15 in Copenhagen in December 2009
- But still there is the need to ensure a peak in CO₂ emissions before 2020 and at least a 50% reduction in the long run on a global scale e.g. in 2050 and later close to zero or even negative



About Denmark



Capital: Copenhagen

Official language: Danish

Government: Parliamentary democracy and constitutional monarchy

Population: 5.5 million

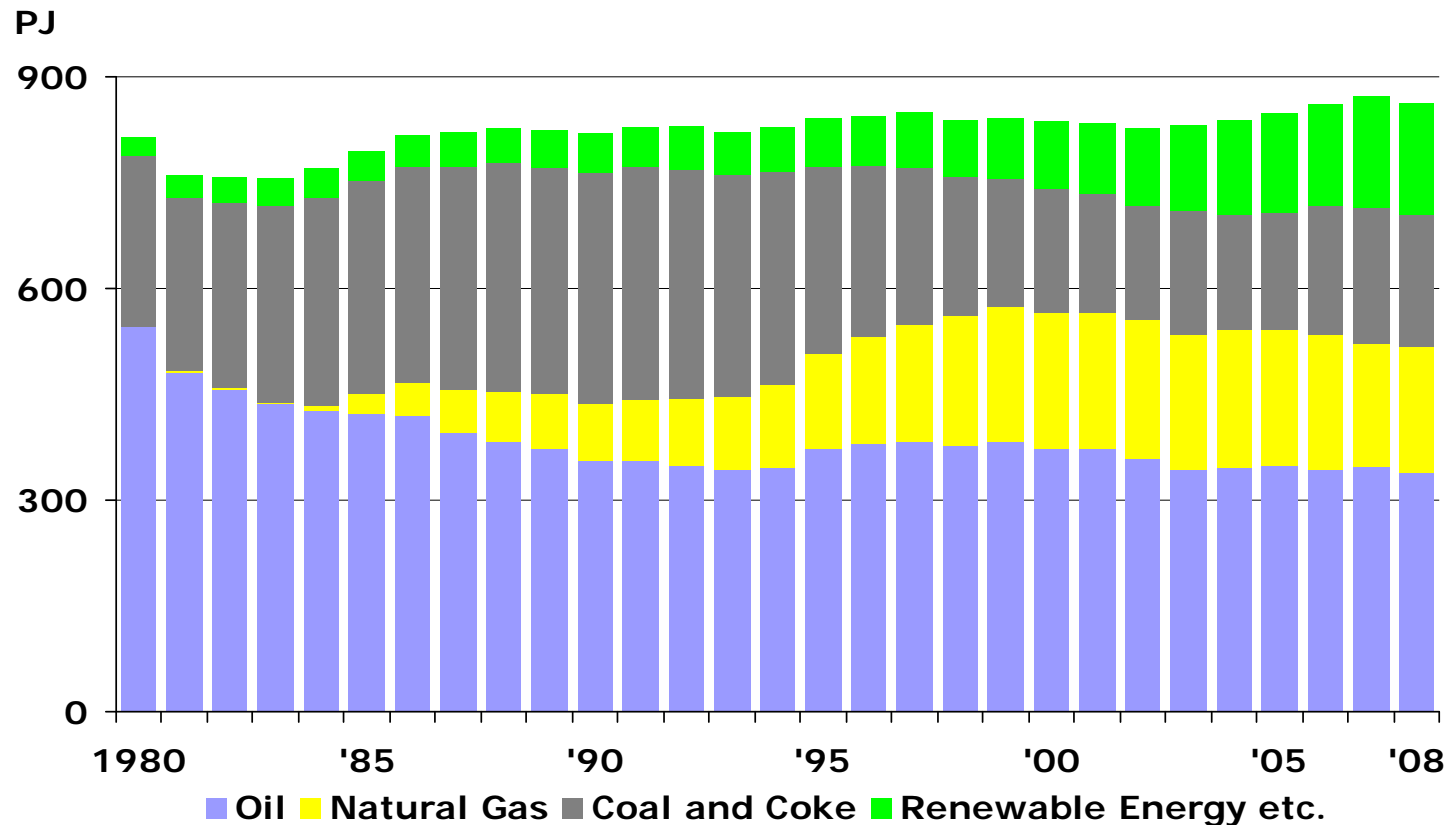
Currency: Danish Krone (DKK)

Area: 43.000 km²

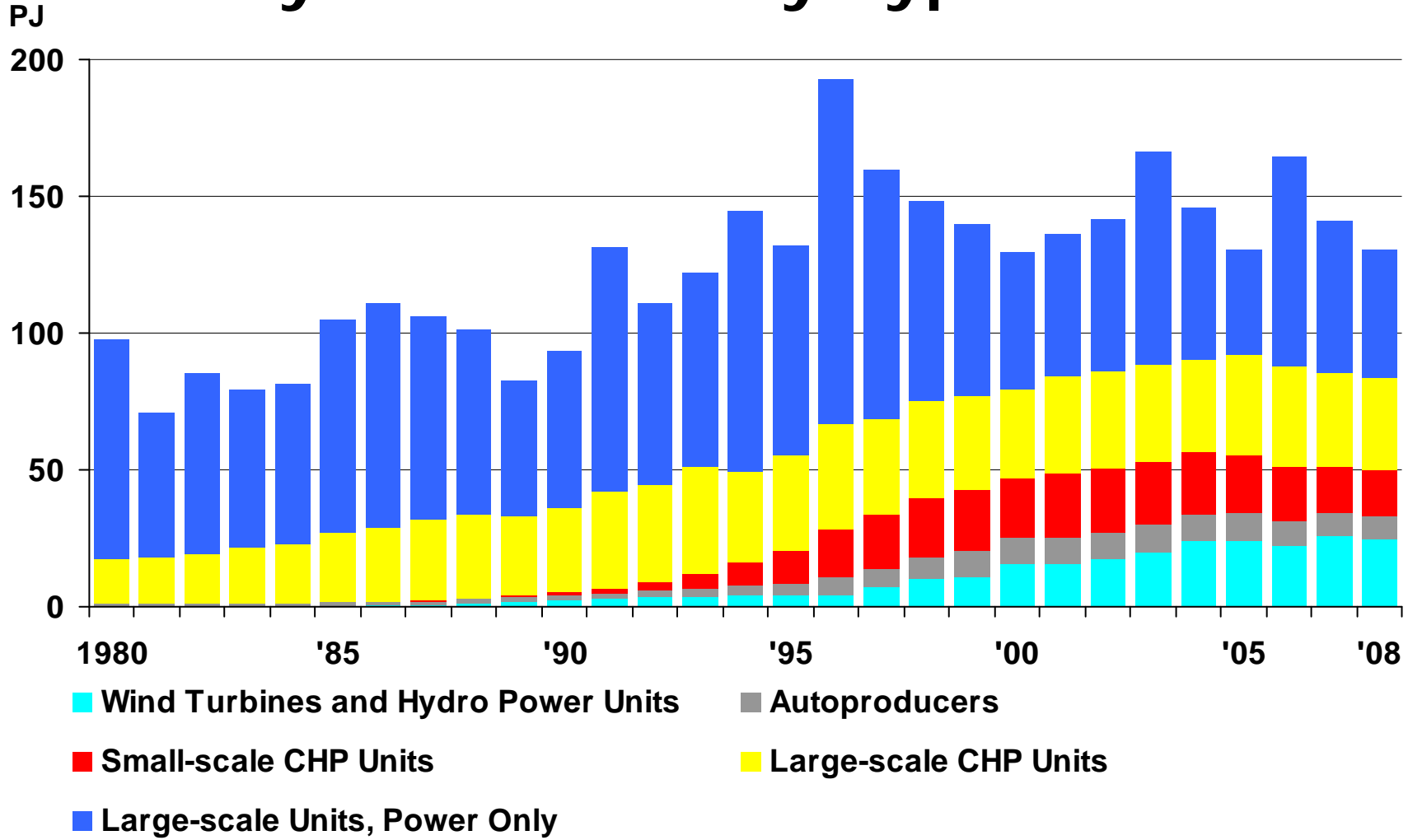


Danish energy consumption has been stable over the last 25 years

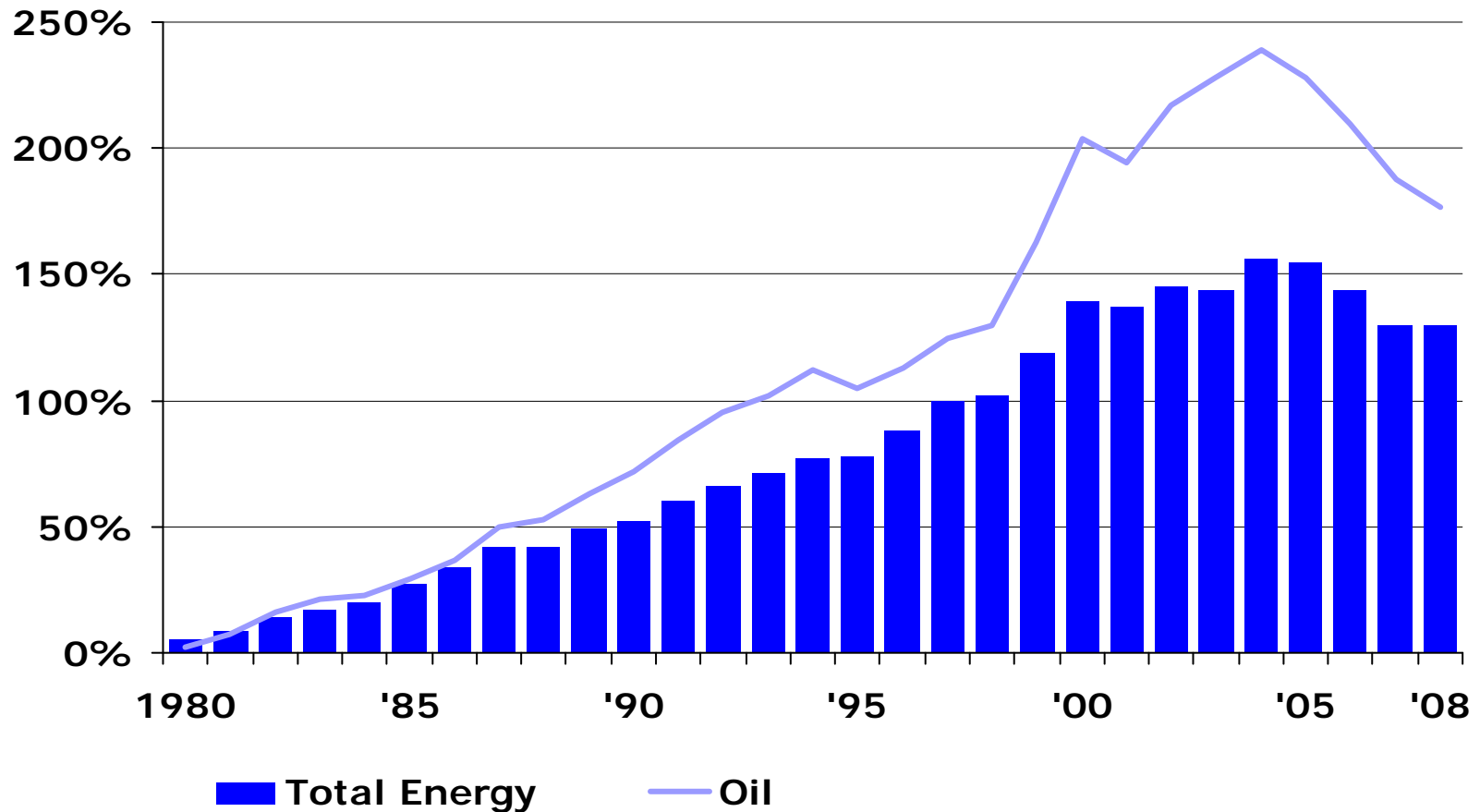
- Is it possible to continue ...?



Electricity Production by Type of Producer



Degree of Self-sufficiency



WEC 2010 Assessment of country energy and climate policies

- Underlines that Denmark has a high proportion of renewable energy and is aiming higher.
- That Denmark in 2009 has launched the worlds largest off-shore wind farm to date, Horns Rev 2.
- Denmark's policy is based on Fit in Tariffs, whose end-cost are recovered from consumers.

Northern Europe

- Norway is to a very high degree based on hydro power, and has huge oil and gas reserves. For the future the country is aiming at developing its renewable potential like off shore wind.
- Sweden has based its electricity production on a combination of nuclear and hydro power.
- Germany is using nuclear, coal and gas as well as a large amount of wind - more than 18 GW installed in 2010.
- All these countries are interlinked with Denmark and trades continuously electricity.



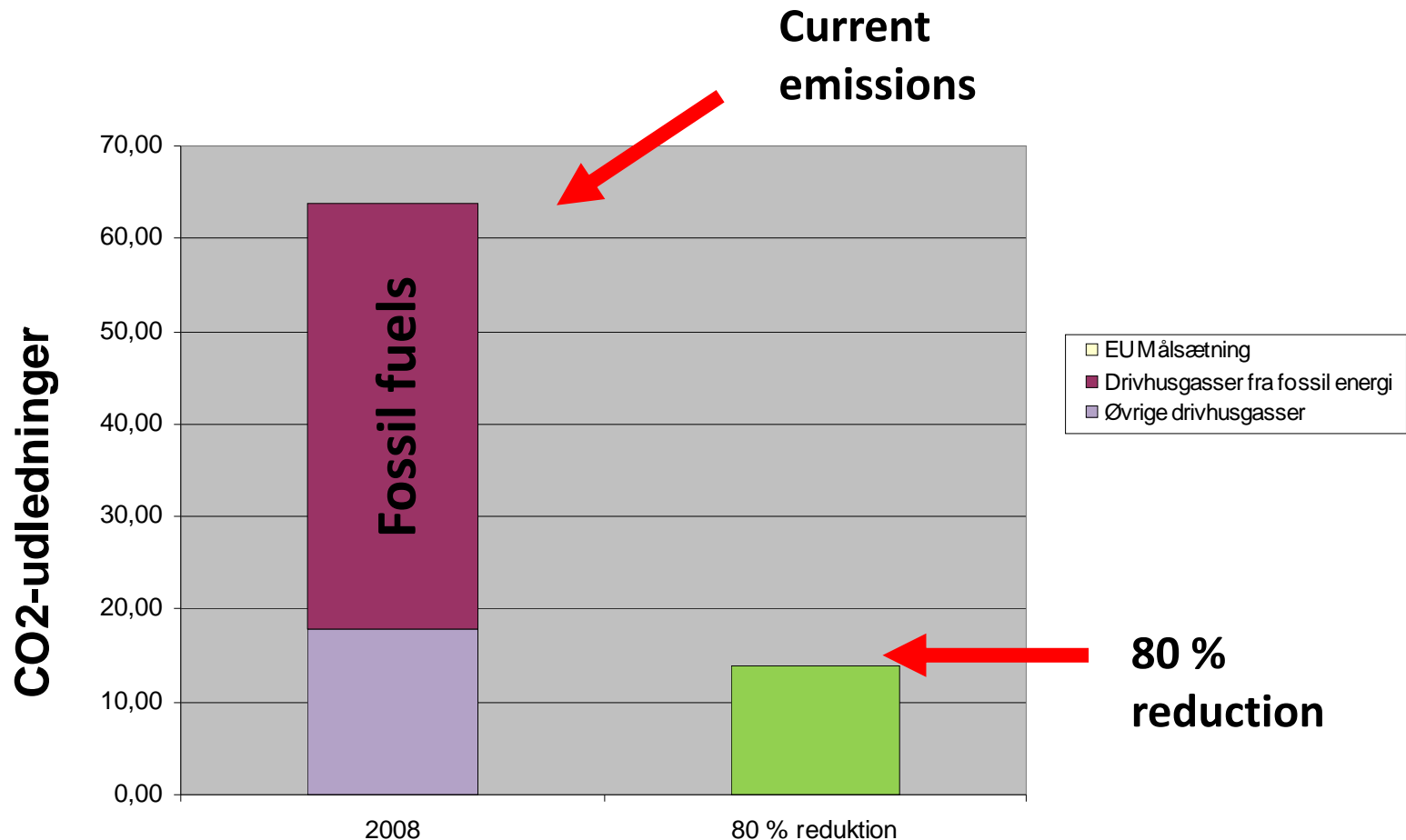


Green energy

– the road to a Danish
energy system without
fossil fuels

The Report of the Danish Commission
on Climate change

Challenge: Fossil fuels make up the bulk of carbon emissions. Effort is necessary in this area in order to achieve the goal



Results of the Commission on Climate Change Policy

- Denmark can become independent of fossil fuels by 2050.
- Even as our energy demand doubles.
- The technology is available today, but more will become available.
- Small additional cost as continued dependence on fossil fuels will become an expensive habit.

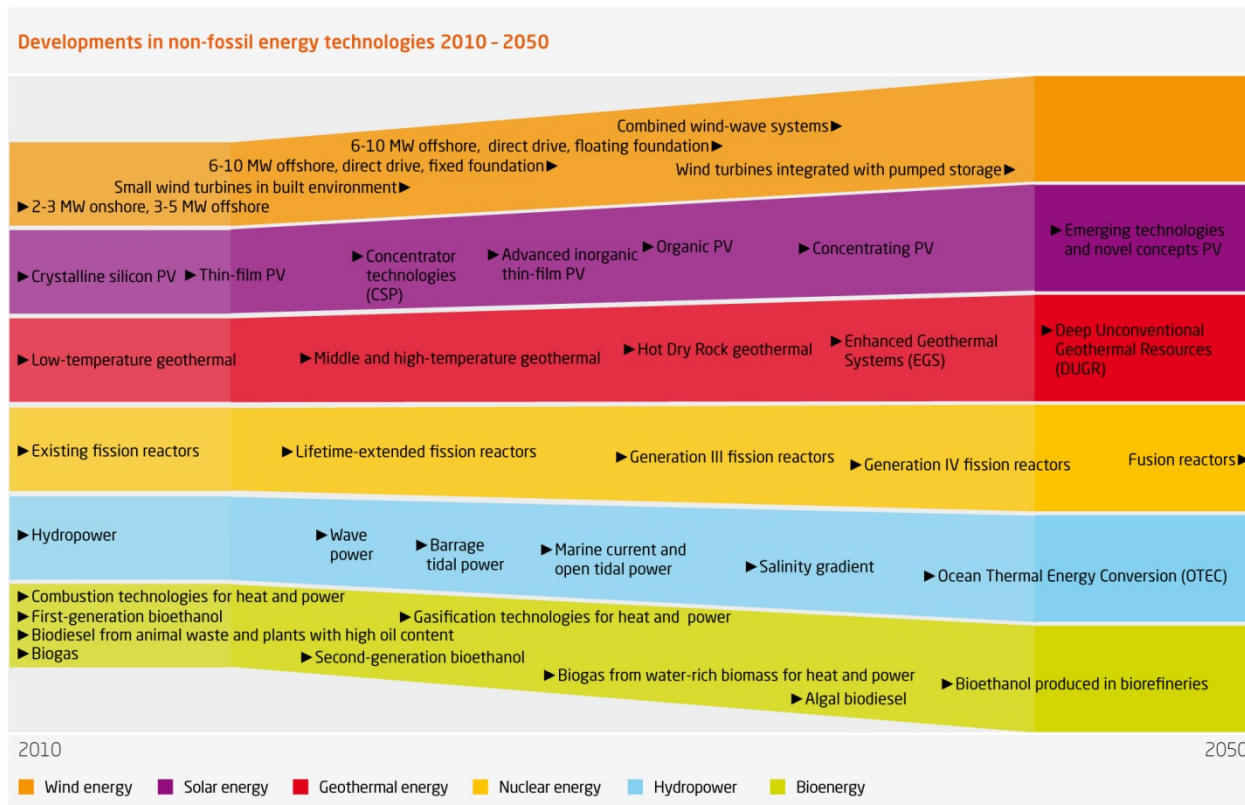
Risø Energy Report 9

The report is volume 9 in a series that began in 2002

- By 2050, the sum of the potential of all the low-carbon energy sources exceeds the expected demand. The challenge is therefore to utilise this potential in an economically attractive way.
- It will not be possible to develop the energy systems of the future simply by improving the components of existing systems. Instead, we need to optimise the entire system, from energy production to efficient end-use.
- This will require paradigm shifts as well as evolutionary changes.
- Written by researchers from DTU together with other Danish and International experts
- Based on the latest research results together with available international literature

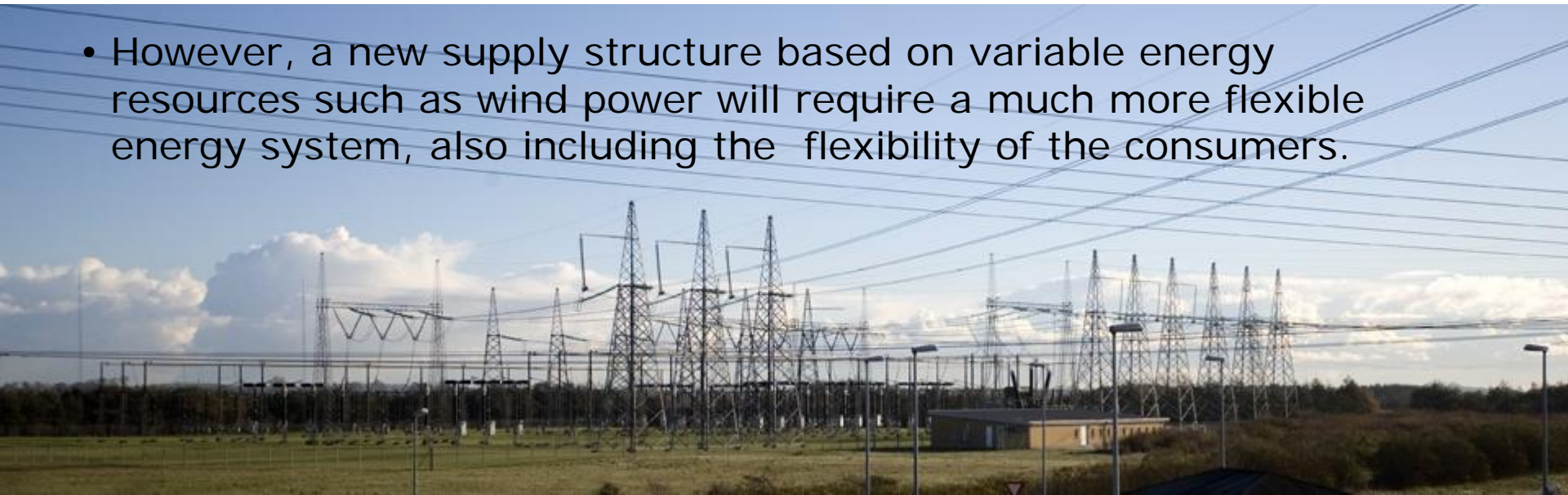


Risø Energy Report 9

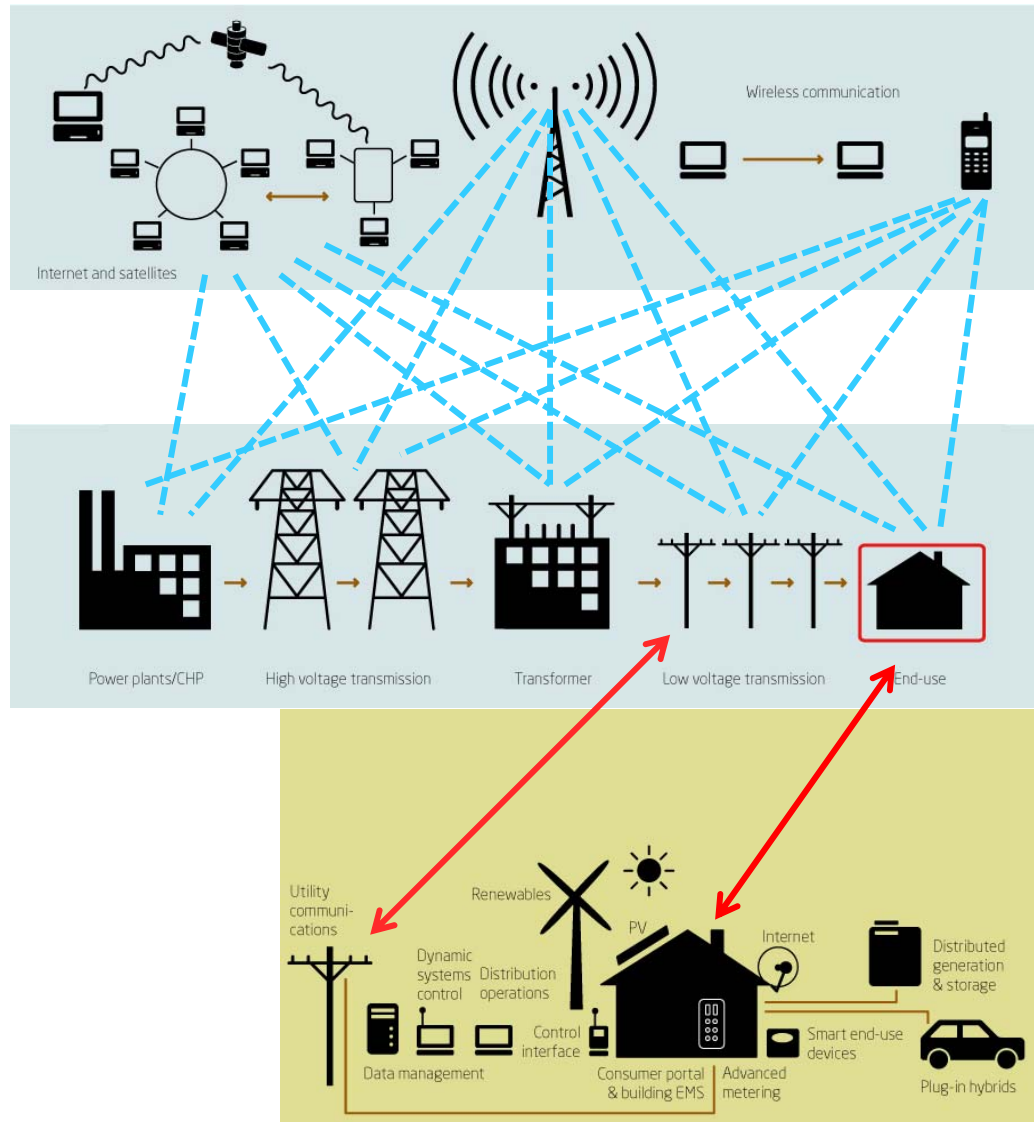


The energy system

- Today's energy system is the result of decisions taken over more than a century.
- This long-term development is reflected in the structure of the energy system, which in most cases was developed according to basic engineering requirements: energy is produced to meet the needs of consumers.
- However, a new supply structure based on variable energy resources such as wind power will require a much more flexible energy system, also including the flexibility of the consumers.



The future intelligent energy system



Information and
Communication
Technologies

+

Traditional power
system structure

+

Distributed generation
and efficient building and
transport systems

=

**The future intelligent
energy system emerges**

Flexible and intelligent energy system

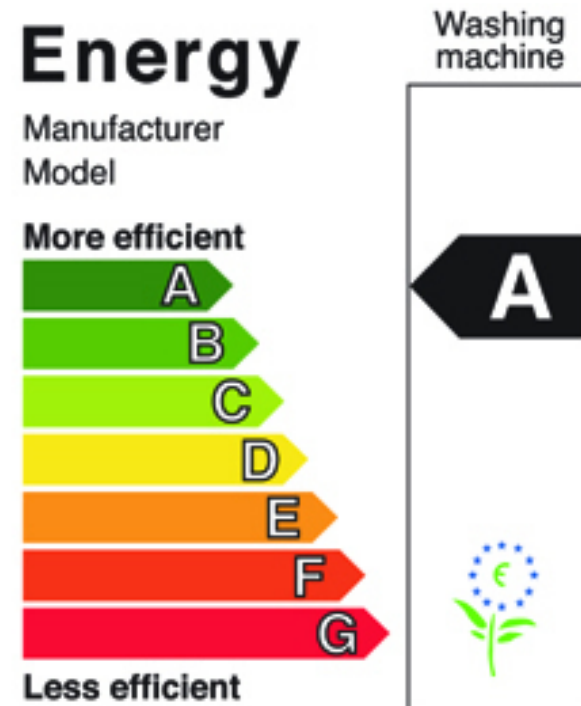
Prerequisites:

- effectively accommodate large amounts of varying renewable energy;
- integrate the transport sector through the use of plug-in hybrids and electric vehicles;
- maximise the gains from a transition to intelligent, lowenergy buildings; and
- introduce advanced energy storage facilities in the system;
- Development of supergrids interconnection different regions



Efficiency improvements

- High emphasis on efficiency improvements in both industry and private households changing demand patterns are going to generate new challenges to system operators and utilities.



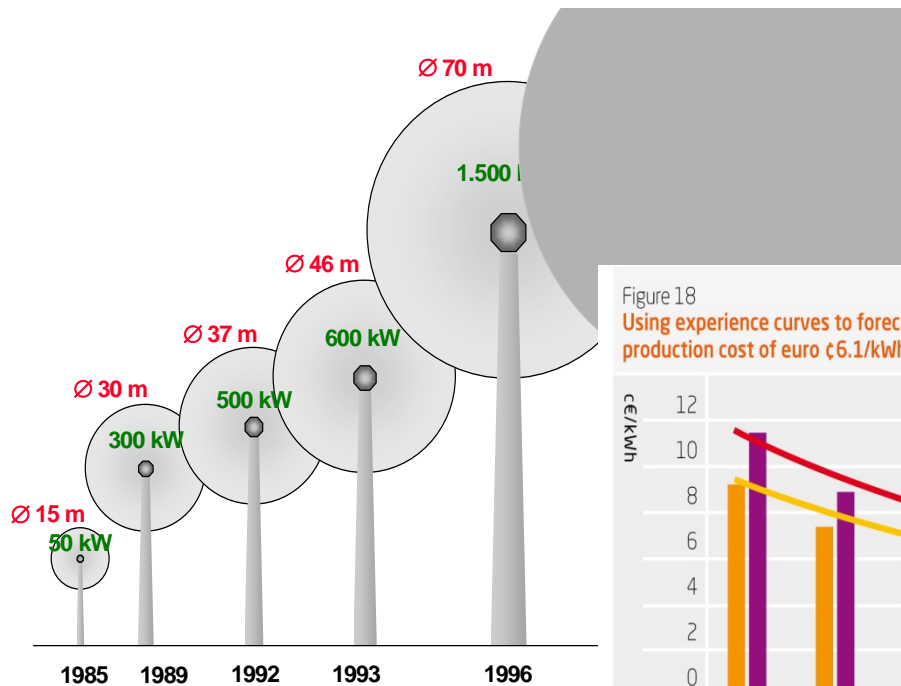
Self sufficient costumers

- The customers are becoming increasingly independent as they in long periods can be self-sufficient with energy by producing some of their limited need for electricity and heat by solar collectors, fuel cells etc.
- In short periods of time they are expecting the system to supply all their needs.



Wind energy

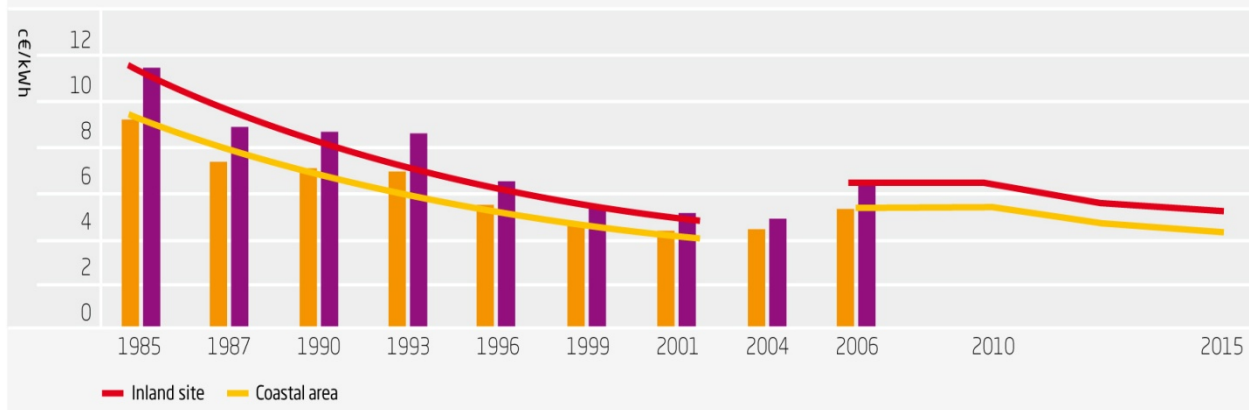
Development of wind turbines



Cost of energy from wind and fossil fuels

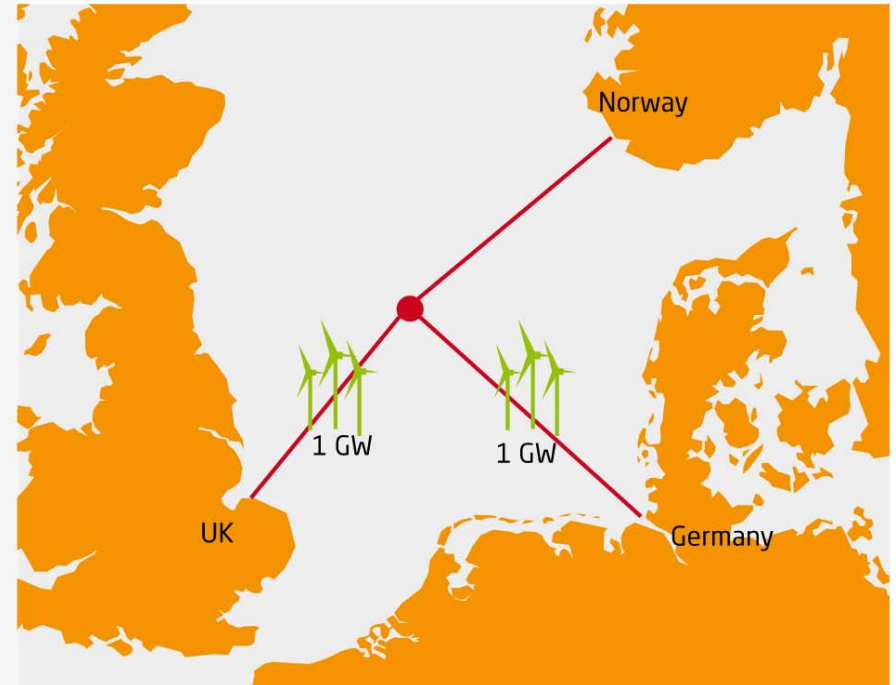
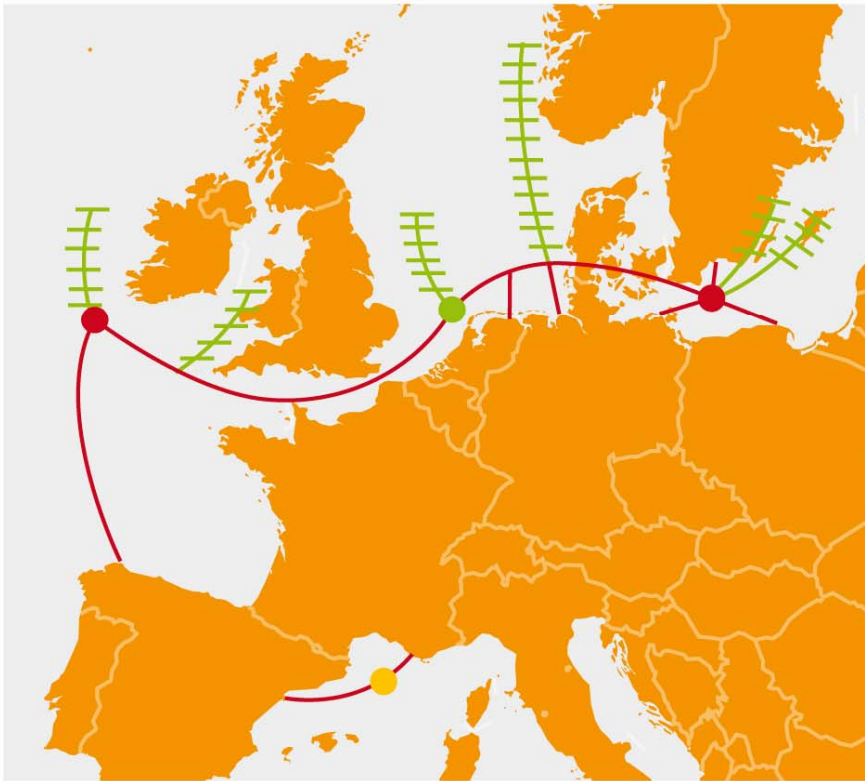
Figure 18

Using experience curves to forecast wind energy economics up to 2015. The costs shown are for an average 2 MW turbine with a present-day production cost of euro €6.1/kWh in a medium wind regime. From [3]



The SuperNode configuration

Figure 43
The SuperNode configuration could be a first step towards a European supergrid. It would allow the three-way trading of power between the UK, Norway and Germany, and would include two 1 GW offshore wind farms, one in the UK and one in Germany. To balance fluctuations in wind power, up to 1 GW could be transferred between any two of the three countries [6].





World Wind Energy Report 2009

Technology for sustainable energy supply - Bioenergy

- Production and properties of biomass
- Biomass conversion and co-production
- The production of 2 generation bio-fuel from straw by means of an internationally unique method



Storage

- Energy storage is needed in a future energy system dominated by fluctuating renewable energy depends on many factors:
 - the mix of energy sources,
 - the ability to shift demand,
 - the links between different energy vectors, and
 - the specific use of the energy.
- Storage costs and energy losses need to be considered.



Transport sector

- Modern transport depends heavily on fossil fuels. Ways to reduce emissions from transport are to shift to renewable or at least CO₂-neutral energy sources, and to link the transport sector to the power system.
- Achieving this will require new fuels and traction technologies, and new ways to store energy in vehicles.



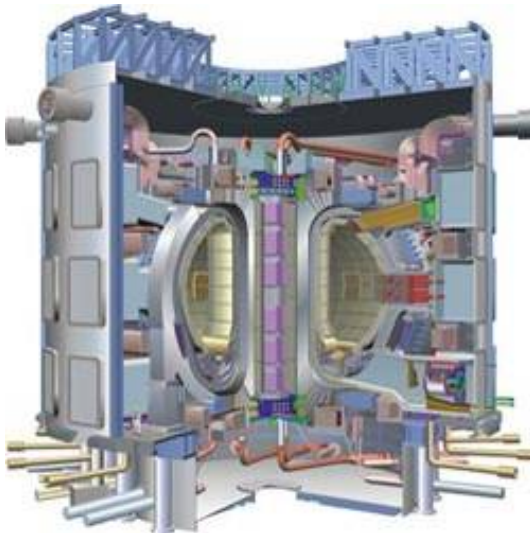
Long term development

- Apart from development of the future highly flexible and intelligent energy system infrastructure which facilitates substantial higher amounts of renewable energy than today's energy system
- there is also the need for development of new sustainable supply and end-use technologies for the period after 2050 where CO₂ emissions should be almost eliminated

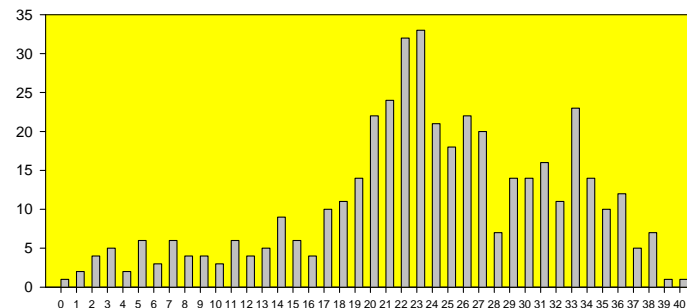


Fusion and Nuclear fission energy

- Over the last five decades significant effort has been put in **fusion energy** research in Japan, the US and Europe.
- Europe is the host of the new international fusion experiment ITER Expected to start operating in 2020.
- Maybe the first commercial fusion reactor will be commissioned in 2050.
- **Nuclear fission energy** provides 15% of the world electricity production. Globally, 440 reactors are in operation in 31 countries with most of the nuclear generation capacity being in Europe, in the US, and in Southeast Asia.
- The next generation of nuclear energy systems, Generation IV, may be deployed from 2040 onwards.
- Most projections from IEA, IPCC and others expect some growths in the installed capacity of nuclear energy in the coming decades.



Number of reactors by age (as of 10 May, 2007)



Long-term research

- Hence, there is a strong need to pursue long-term research and demonstration projects on new energy supply technologies, end-use technologies, and overall systems design. Existing research programmes in these areas should be redefined and coordinated so that they provide the best contribution to the goal of a future intelligent energy system.



Thank you for your attention